Research Note

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NEW FACTS ON LIGHTNING

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There are many more phases of the forest fire problem than our Experiment Station Division of Forest Protection is or should be financed to study. One of these includes the fundamental characteristics of lightning. While the nature of lightning is one of the most talked about features of the forest-fire problem, and while we can always do more to control a menace which we understand than one which is mysterious in its behavior, the study of million-volt lightning bolts occurring in a few millionths of a second is clearly a field for the electrical engineers, not foresters.

The Experiment Station has a definite responsibility, however, to keep informed of progress in this field and to relay significant information to fire control officials. We have been fortunate in that respect by obtaining the personal interest of Dr. K. B. McEachron, Director of the high voltage research laboratory of the General Electric Company at Pittsfield, Massachusetts. One of his assistants, Dr. E. A. Evans, worked one summer as fire-weather observer at our Priest River branch station. Both of these men appreciate the vital part which lightning plays in the northern Rocky Mountain job of forest-fire control.

Recently Dr. McEachron furnished us with summaries of some of their studies, largely made at one of the most lightning-struck spots in the United States, the 1,250-foot Empire State Building in New York City. The most significant and most interesting findings, to us, are as follows:

1. Fire control men have long contended that there are two kinds of lightning, generally fire-starting and generally nonfire-starting. Eleven years ago Seley W. Moore of Darby, Montana, a lookout for two years, reported his observation that red lightning, though often tearing trees to pieces, seldom starts fires, while the bluish-white type is usually effective. Dr. W. J. Humphreys of the Weather Bureau explained this, in the December 1931 issue of the Monthly Weather Review, as possibly due to the fact that "a lightning discharge through heavy rain may well dissociate some of the water, or water vapor, along its path, and thereby produce........the hydrogen spectrum, which is brilliantly red........" A flash through dry air on the other hand emits light due almost entirely to the oxygen and nitrogen of the atmosphere, and is primarily white or bluish-white. Humphreys concluded: "In short, it is not the difference between white lightning and red lightning that makes the one a greater fire hazard than the other, but the condition, wet or dry, of the combustible when struck."

Too many of us have seen too many forest fires started by lightning during and after drenching downpours to accept this as a complete explanation. Fuel moisture undoubtedly determines whether or not the fire will spread, but lightning continues to tear trees to pieces on dry days without starting fires, and it continues to start fires when the woods are so wet that the smoke-chasers have to hurry or the fire will go out before they get there. Obviously there must be other "kinds of lightning" besides red and white.

Dr. McEachron reports that their photographs, taken on film moving past the lens at 124 to 218 feet per second, show that there are two other kinds, (1) the so-called single stroke which, once the path is established, occurs in only a few millionths of a second, and (2) the continuing type which sends bolt after bolt crashing along the same path. He states: "It is the continuing type of lightning strokes which persist for fractional parts of seconds which cause fires, rather than the high-current, short-time discharge (lasting but a few millionths of a second) which blow trees apart."

2. Although the human eye and brain cannot distinguish between a few millionths and a few more millionths of a second, the bulk of the continuing type of flash can be distinguished because the average repeater lasts for nearly half a second. The record-breaking stroke, so far measured, consisted of flashes repeating over the same path for a full 1½ seconds.

Coupling this with Humphreys' deduction, it appears that the long-duration white flash is definitely our most dangerous type, while the extremely short red flash is probably only rarely a fire starter.

3. From their photographs of lightning striking the Empire State Building, Dr. McEachron reports "Every stroke but two of which the author has record, either struck the highest point on the building or outside a cone the base radius of which at ground level of the building was equal to the building height." Poles bearing lightning arresters just outside a lookout or ranger station building obviously should be so located that all parts of the pole are within this cone of protection created by the lightning arrester on top of that building. Otherwise that pole should have its own lightning rod. As is well known, however, even a tall or high arrester is ineffective unless the resistance to ground is low.

4. From measurements made in Colorado, Dr. McEachron concludes that the strength of a lightning current striking at high elevations is usually much less than for bolts reaching down into the valley bottoms. "The observed stroke current decreases with increase in altitude from sea level to 13,500 feet. Results indicate that there may be no lightning strokes if the ground level is above an altitude of 18,000 feet." At the highest altitudes at which measurements were made the strength of current ranged from 2,000 to 96,800 amperes.

5. Geological and mineral formations "do not appear to influence the locations where lightning strokes occur, nor the value of current in a stroke. In fact, contour of the ground and its relation to direction of travel of the storm appears to have more bearing..........."

No mention is made in McEachron's reports concerning the relative susceptibility of different species of trees. Undoubtedly he would like to have foresters furnish such data. Apparently "contour of the ground and its relation to direction of travel of the storm" must also be considered as well as the

several tree species present, and the particular species struck. Ground contour, direction of storm travel, elevation of the cloud base, wetness of the air, and wind direction and velocity at time of the strike, are some of the factors which have not been considered in previous "studies" of susceptibility of different tree species to lightning strokes. Dependable knowledge in this field might be useful in selecting the kind of tree on which to hang each phone line insulator, when a choice is possible. Small changes in line location also might avoid certain "ground contours" especially susceptible to lightning strike, and take advantage of nearby slopes having "ground contour in relation to common storm path" which is generally safe.